Description of surficial deposits map units

Description of bedrock lithology Suitability for construction Special problems Susceptibilty to frost action Topography and drainage Permafrost Distribution and thickness Description of materials Upper-and lower-case map symbols listed in column at left edge of table: lower-case map symbols explained in adjoining Description of Surficial Glacial streams and Tazlina Lake subject to Except for flood hazard due to spring runoff and Deposits Map Units. Sources of information listed at bottom of each column. Water-washed and deposited boulder, cobble, and Distributed in floodplain and low terraces of major Permafrost may be present locally in silty overburden Form narrow to broad incised floodplain and low-Generally not frost-susceptible except for silt summer glacier discharge, gravel of floodplain sudden (overnight) rise in stage if as much as pebble gravel, sand, and silt, with local organic stream systems, including broad outwash plains in of terraces, but generally appears absent in coarsebeds and lenses that increase silt content of terrace surfaces as high as 15 to 20 ft (5 - 6 m) above provides level ground and good near-surface materials; naterial. Forms lenses and thin to thick beds; local front of glaciers and modern fan deltas fronting i grained fluvial deposits that are warmed by heat alluvium to more than 6% and for isolated the river, principally along Nelchina, Little Nelchina and dumping of ice-dammed lakes. Gravel ma however, borings should be drilled to check presence or Flood-plain and low-terrace alluvium imbricate structure. Large boulders and other condition from bodies of surface water and by lakes such as Tazlina Lake. Thickness of alluviur Tazlina, and uppermost forks of Matanuska River, and occurrences where disintegrating shale clasts contain coal and chert; in some areas absence of liquefiable saturated sand and silt and under downcutting streams in canyons probably less convection from moving ground water discharging to contains shale clasts that cause failure of South of Glenn Highway and west of South South of Glenn Highway between South Fork South of Glenn Highway between Nelchina South of Glenn Highway and east of Tazlina North of Glenn Highway permafrost conditions. Low terraces are less subject deposits through which canyons have been cut; bedrock the stream. No subsurface data available. than 23 ft (7 m), as modern paleo stream scour. colluvial slopes and sheer bedrock bluffs. Alluvia suitability tests for concrete aggregate. Unit Matanuska River and Nelchina Glacier and Glacier and River and Tazlina Lake and Lake and Glacier Fork Matanuska River Thickness may be greater in outwash plain and in fansurfaces well drained, but subject to river flooding at a of saw-quality timber. erosion of canyon walls; locally shale boulders delta environment where fluvial tooset beds lie above recurrence interval ranging from about 1 in 2 years or disintergrate rapidly to form silty angular pebbly sandy foreset and silty bottomset beds. lowest surface to a much greater interval on terraces matrix for gravel. In general, however, sandy matrix Undifferentiated siltstone, sandstone, and Undifferentiated siltstone and sandstone Not present. Undifferentiated siltstone, sandstone, and contains less than 6% silt sized material. deposits Tazlina Glacier discharge are much as conglomerate of Matanuska Formation. generally coarser upstream, near glacier sources 5 ft (2 m) above normal lake level and perhaps triple normal streamflow at irregular intervals Chiefly pebbly sandstone of Cretaceous age Conglomerate and sandstone of Talkeetna Not present. Channel sandstone and conglomerate of and siltstone, sandstone, conglomerate and Formation and terrestrial conglomerate and Cretaceous age, outlet Tazlina Lake. sandstone beds and lenses of Cretaceous age Water-worked and deposited boulder, cobble and Forms terraces along stream courses generally above Permafrost probably present in high terraces along Generally not frost-susceptible except for silty Terraces bordering modern streams generally more carbonaceous conglomerate of Tertiary age. sandstone of Chickaloon and coal-bearing vegetation overburden than lower terraces, and pebble gravel, sand, and silt, with local organic flood level; covered by silty organic soils that support than 15 ft (5 m) high, broken by tributary gullies; locally covered by fan or colluvial deposits along bluff modern streams, but sporadic in distribution. Permafrost may be absent to sporadic beneath former beds and lenses that increase silt content of pebbly sandstone with siltstone an greater chance for frozen ground, in deposits along concretions of Tuxedni formation; fluviatile aterial. Forms lenses and thin to thick beds: loca mature spruce forest with heavy moss cover. Deposits material to more than 6%. iver; the higher terraces offer gullied sites have imbricate structure. Large boulders and other outwash channel systems which are seasonal strea conglomerate and locally coaly sandstone of Terrace, deltaic, and outwash deposits at valley margin. Well to poorly drained in thick moss, good drainage and materials, access to granular borrow material winnowed from glacial and glaciolacustrine 7 m) on major streams; deposits on former deltas may silt mantle, and dense woods. Abandoned deltas and courses and discharge areas for ground water, and be 10 ft. (3 m) thick and lie above sandy foreset be deposits through which the streams cut to depo outwash channel terraces deposits, by contrast, are alluvium, Generally less than 6% silt, except for loca deltas have excellent topography, materials, and water and silty bottomset beds. Former outwash deposits of generally burned over, well drained to droughty, but ice settlement problems unlikely in these granular Volcanic wacke and sandstone of Talkeetna Chiefly volcanic sandstone of Talkeetna Chiefly sandstone, some shale, siliceous Sandstone, lesser shale and siltstone, deposits; no subsurface data available. Fine sandstone, sandstone, and siltstone of braided channels apparently only 10-15 ft (3-4.5 m) silt lenses and beds; contains local concentrations have a generally higher water table than the terraces formation and sandstone of Matanuska shale, and siltstone of lower part of siliceous shale and zeolitized sandstone; oversize material; generally becomes finer downstream in former fluvial and outwash terraces; Cretaceous age; sandstone, some siltstone of Matanuska Formation; also sandstone of limestone beds. Formation. Formation. Calcareous sandstone of becomes finer at depth in former deltaic deposits. Cretaceous age. Minor shale and pebbly Linear deposits of limited thickness useful only Deposit is really too thin and of too limited areal Principally found along shoreline about 2.450 ft (747 Forms single to multiple elongate beach ridges less Permafrost is not present within the shallow zone Rounded to subangular, well sorted, accumulation of Not susceptible to frost action. for road or airfield alignment or for providing extent to be considered for major construction sites Siltstone, claystone of upper part Matanuska Siltstone, claystone, some sandstone with occupied by beach deposits, but may occur at greater Thin beds siltstone, claystone, some pebbles and cobbles as large as 1 inch (3 cm) in m) above sea level marking one of the last major lake than 10 ft (3 m) high and individually about 15 ft (5 m) small amounts of borrow. limestone concretions and graded sandstone layered chert, calcareous concretions; minor Formation, some sandstone interbedded with lenses of sandstone and conglomerate. However, it is suitable to excellent foundation and across, though they do occur in groups aggregating 330 diameter, granules, coarse and medium sand. Commonly rests on or grades into wave-winnowed stands with a semi-stable outlet. Deposit is seldom as structure and limestone concretions; hard wide as 330ft (100 m) across series of beach ridges, ft (100 m) in width. Deposit is well drained and siltstone and claystone; local graded sandstone beds. Rocks of Jurassic and Commonly claystone or marine shale. boulder concentrations at base of deposit and top of and is more commonly a single poorly-developed beac generally entirely above the water table; supports ridge, 6-10 ft (2-3 m) high, and containing, perhaps 6 ft underlying till; may merge laterally to lag boulders a aspen and other forms of dry land vegetation. Cretaceous age. Not present. Not present. Generally not suitable for construction because of No information on permafrost, other than speculation Largely concentrated along base of river bluffs and Localized on lower third of slopes of river bluffs and Locally contains more than 6% silt which when steep slopes, poor materials, local seepage sites for gullying, mudflow activity, creep, and landsliding the remedial work. that it is probably present, particularly on shaded include cones, fans, creep deposits, and landslides too other breaks in slope, and extend out onto adjacent wet is subject to frost action. Andesite, andesite and dacite, basaltic Undifferentiated volcanic rocks, tuffaceous Andesite and basalt flows, tuff, tuff-breccia, Andesite and basalt flows, tuff, tuff-breccia, ground-water discharge (winter icings), and, mix and redeposit material from bluffs to the base of small to map individually. Thickness less than 33 ft stabilized north-facing slopes, and to a lesser extent Lavas and pyroclastic rocks of intermediate plains at base of slope. Relief is uneven reflecting andesite or undifferentiated intermediate and volcaniclastic sediments, of basalt or and marine and nonmarine volcanogenic and marine and nonmarine volcanogenic particularly because of active slope movement, such as composition; sandstone and argillite landslide, gravity, and mudflow and rill-forming gull on south-facing slopes. the bluffs. Generally non stratified to poorly or (10 m), wedging out to upslope boundary and sedimentary rocks; Talkeetna Formation. dominantly marine; largely Talkeetna irregularly stratified; locally mixed with organic irregularly thinning downslope to toe of unit, action. Unit drains at a steep gradient downslope marine sandstone and argillite; Talkeetna commonly deposited on alluvium. through gully or rill system; rapid runoff. Soils dry and well drained in some places, wet and plastic in slumps Andesite and tuff, lithic tuff (predominantly Ignimbrite (a consolidated ash flow or nuce Included within Vu unit. Included within Virunit material other than pyroclastics), and crystal ardente deposit); layered welded pyroclastic: Fair to poor for construction because of fine-grained Probably not susceptible to frost action because lithic tuff (non-pyroclastic material medium to well compacted fine to very Localized along tops of bluffs bordering incised rivers Forms low, linear ridge along top of bluff. Drainage Growth of aspen and dry soils suggest that no Stratified coarse to fine sand, sandy silt, and silt, foundations and borrow limited on site to sand or silty usually the south facing bluff where winds off the of lack of water in soils that are generally coarse grained water-laid tuff with angular permafrost occurs within the eolian deposits, except excellent at summit, but poor on side away from bluff sand. Risk in location adjacent to steep bluffs, which Chugach Mountains have blown up over the cliffs to or the possibility of some minor shallow permafrost fragments. In thin layers; locally form cliffhead dunes. Deposit generally less than 10 ft on the slopes away from the bluff face. Site is dusty as material is blown up over clif (3 m) thick, but may reach as much as 33 ft (10 m errain broken by ridges and deep gullies. Quartz diorite and tonalite, locally sheared (where dotted on map); felsic intrusives such dikes, locally porphyritic; quartz diorite dikes, locally porphyritic; quartz diorite dikes, sills, and small stocks that are mostly biotite hornblende granodiorite; minor quartz porphyry; medium-to coarse-grained as quartz porphyry; and some intermediate containing plagioclase, quartz, hornblende dacite and larger bodies of biotite- amount of tonalite. plutonic rocks or mixed mafic and felsic and biotite; locally intruded by sheeted mafic hornblende granodicrite. Shifting stream channels; mudflow and potential Susceptible to frost action where silt content Distributed along northern front of Chugach and eastern and southern front of Talkeetna Mountains and In plan, a triangular or fan-shaped map unit, with apex Permafrost probably discontinuous, and more likely to stream channels; generally dry, firm foundations with minimum permafrost problems and good sources of avalanche hazard. exceeds 6% and where water is present, extending up lower third of hillside, and remainder in be prevalent and thickest in toe area where drainage is mapped upslope from upper end of fan; matrix sandy, especially in the toe of many fans; coarser silt along major valleys within these mountains. Thickness lowlands. Considerable relief from apex to toe; poor and ground-water circulation lower than other Gabbronorite, fine-coarse textured, sheared Gabbro, coarse to medium, sheared (where Mafic plutonic complex, includes layered Mafic plutonic complex, includes l slightly silty; boulders to granules. Poorly stratified orrow are favorable in all except wet toe area of fans Alluvial-fan deposits unknown, but probably generally less than 33 ft (10 m), areas of coarser materials and higher ground-water free gravel not subject to frost action. perhaps 10 - 20 ft (3-6 m) local relief at stream hornblende-pyroxene gabbro and leucogabbro, minor ultramafic bodies, diorite and minor ultramafic bodies, diorite and tonalite. where soils are fine grained. Care should be taken to (where dotted on map); diorite and dotted on map), pyroxenite, horblendite, channels. Gravelly deposits well drained on upper and tonalite/quartz diorite; pyroxenite; gabbro and quartz diorite (undifferentiated), locally be in excess of void spaces of fine-grained middle parts of unit, but finer material having very bordered stream courses and silty soils. pyroxene-hornblende gabbronorite with cut by basic and intermediate and by tonalite. Layered quartz gabbro body is a low slope near toe is poorly drained and locally undifferentiated sheared intermediate and diabase/basalt dikes. large tectonic inclusion within McHugh covered by swamp and muskeg. complex (Mo) and is surrounded amphibolite facies rocks and orthogneiss; her Permafrost probably prevalent but thickness not Widely distributed in mountains and basins above 2,450 General topographic form is alternating low ridges and Nonsorted, nonstratified, inhomogeneous mixture of degree of frost susceptibility wherever water is ft (747 m) as surficial deposit, but below 2,460 ft (747 m) is commonly covered by thin lacustrine deposits swales oriented as shown by drumlin symbol, in the known; probably more than maximum recorded Body of serpentinized pyroxenite within Serpentinized pyroxenite. potential for thaw settlement in areas of ice-rich boulders, cobbles, pebbles, sand, silt, and some clay. Serpentinite. Not present. direction of ice movement. Net relief of 3 - 33 ft (1permafrost, poor soil drainage, and local hummocky Not present. mafic plutonic complex near head of Bottley Coarse material generally angular to subrounded. Well where ground temperature is affected by bodies of running or standing water. May contain ice-rich zones 10 m) little modified by overlying lacustrine deposits graded or poorly sorted; locally compact. Where a thin (where lc/gm). Drainage fair on ridge tops where slope Ground moraine (till) veneer, shown as gm/Vu, where overlying volcanic that would cause differential settlement upon thawing. is adequate to drain overland, but poor where level. but locally it overlies other deposits, e.g. in thick rocks; generally covered by lacustrine deposits that sections along Nelchina River and Tazlina River. Poor internal drainage in silty till. Phyllite, locally chloritic, and thin bedded Schist, graywacke, quartz sericite albite Marine argillite, siltstone, sandstone, and Not present. are shown as lc/gm. Crystalline glacier ice having a Not present. slow downvalley motion; buried by firn or perennial snow above about 4,500 ft (1,375 m), depending on metagraywacke and metagreenstone beds and chlorite schist, graphitic. Also lenses. Grades westward into rocks more conglomerate, sandstone, and siltstone, amphibolite facies, locally gneissic; intruded weakly foliated greenstone with pillow Glacial ice is not a soil that is susceptible to Glaciers below the firn line are melting and are being Distributed as neve fields and small ice caps that feed Smooth appearing, gently sloping white, clear ice Crystalline glacier ice having a slow downvalley frost heaving, although there is about 11% volume increase when water freezes. large and small valley glaciers in northern Chugach Mountains, e.g. South Fork Matanuska River glacier, broken by crevassed medial moraines along axis of replenished by ice moving downvalley; yet, in a sense glacier motion and its effect on foundations. motion; buried by firn or perennial snow at above glacier, and by crevassed ice falls across the glacier cireenschist and blueschist as blocks in a Greenschist and blueschist as blocks in Not present. Not present. Not present. Nelchina Glacier, Tazlina glacier, and the small alpine Marginal crevasses, lateral moraines and terminal mélange or as continuous belt extending mélange or a continuous belt northeastward Glacier ice conditions. Carries entrained rock debris. placiers area boundary). Thickness of snow and ice not moraines mapped as mic where ice cored, moraines a known, probably several hundred meters within map ortheastward from Neichina Glacier. Not present Not present orthogneiss of tectonic inclusion in McHugl Permafrost probably present, especially in the unit mantled with lake deposits  $(\underline{le}/\underline{ke})$  but may be thin and Although uneven topography, foundations and materials for borrow are generally favorable for Only the silt and clayey horizons subject to Distributed as kames and kame terraces in Chugach Forms ridges of kames and elongated, serpentine Washed sand and gravel, ranging from fine sand and k e ultramafic rocks, banded mafic amphibolit frost action, including the silt mantle of unit Mountains, kames and eskers bordering the Little silt to cobble and boulder gravel. Subangular to rounded, sandy matrix, generally less than 6% silt eskers with intervening swales and marshy areas. sporadic in lateral extent near heat sources such as construction. Some eskers and kames provide large hornblende biotite diorite, quartz diorite Nelchina River and Lake Louise, and as kame-esker Ridges are normally well drained, the swales poorly gneiss, gabbro, and pyroxenite. Foliation or ponds and lakes. Thickness not known. Little or no is generally non frost-susceptible beneath glaciolacustrine deposits in the Late Louisedrained. Through drainage is poorly intergrated. Soil content. Locally contains pieces of coal, lignite or Deposits need to be checked for coal and chert before Kame-esker deposits excess ice in granular material to cause differential Susitna Lake area. Thickness of deposits probably less use as concrete aggregate. Many deposits of this type shale. Where covered by thin lacustrine deposits with than 50 ft (15 m), more likely 10 to 20 ft (3 to 6 m). poor except for unusually sharp ridge crests. little alteration of landforms, mapped as lc/ke. Not present. fine material, and may include local pockets of frost McHugh Complex, a deformed diverse McHugh Complex, a deformed diverse Not present. assemblage that has broad discontinuous assemblage that has broad discontinuous shear zones, and inclusions of marble (Unit shear zones, and inclusions of marble (Uni Mm where mappable). Altered and sheared Mm where mappable). Altered and sheared quartz diorite, diorite, and gabbro, greenschist, blueschist, aligned in matrix of phyllite or argillite; chloritic argillite has Frozen, ice-rich, fine-grained deposits require special Highly susceptible to frost action Wide range of stratified to massive deposits of glacial lakes laid down as mantle over glacial deposits (lc/gm, lc/m) and kame-esker deposits (lc/ke). Range from laminated silt, sand, and clay (sand mapped as s where Nelchina River to altitudes as high as 3,200 feet (975 area, or a thin cover that has a topography that permafrost in map area, probably broken only by permafrost. Sources of granular borrow are remot m); to the south upper limit is about 2,500 ft (762 m), reflects that characteristic of the underlying drift or thawed zones beneath lakes and larger streams. Poor drainage. This map unit, especially le and le/gm, is probably the poorest of any for construction, but wispy lenses of green tuff, thin bedded wispy lenses of green tuff, thin bedded he principal shoreline (mapped in unit b) being 2,450 kame-esker deposits. Lacustrine deposits are poorl Permafrost thickness generally less than but may locally exceed 125 ft (38 m), the greatest known siliceous argillite, argillaceous chert, siliceous argillite, argillaceous chert, Glaciolacustrine deposits known), to massive or poorly stratified stony silt, silty ft (747 m). Thickness of lake-bottom deposits probably drained and are covered by muskeg and stunted black where underlain by gravelly or sandy material,  $\underline{\textbf{lc}}/m,$ massive and pillowed greenstone, tan and massive and pillowed greenstone, tan and gravel (as lenses), sand, and gravel. Much of the nearonly a few m in most places where the short-lived lake permafrost thickness. Ice wedges and masses may be lc/ke, unit has more favorable foundation, material, marine chert and wacke sandstone.

Pumpellyite-prehnite grade metamorphism.

marine chert and wacke sandstone.

Pumpellyite-prehnite grade metamorphism. covered older deposits, the landforms of which are still found in these frozen deposits, but most of the ice and permafrost conditions. preserved. Along Tazlina River and elsewhere in the content is thin layers, lenses, and veins that in many to rounded stones, sand, and abundant silt and clay deeper part of the lake basin, sediments mixed with areas exceed the natural voids of the soil; this excess generally poorly stratified. other material are more than 300 ft (100 m) thick. ice will result in ground subsidence upon thaw of the Marble within McHugh Complex (Unit Mo).

Marble within McHugh Complex (Unit Mo). Not present rectonic melange of blocks of intermediate, Blocks and fragments of gabbro, quartz Tectonic mélange delimiting the Border Tectonic mélange delimiting the Border Ranges fault; blocks and crushed matrix of Landslide deposits are generally uneven and are locally Silty slide materials susceptible to frost action. Form characteristic lobate deposit with steep face at Formed of shale in southeastern Talkeetna Mountains. Permafrost conditions are unknown. Although a few mafic, and ultramafic igneous rocks in a diorite, and volcanic rocks in a matrix of rock fragments, mainly derived from bedrock slide upper Matanuska River tributaries, northernmost still moving as shown by living split trees and ground movement, and adjacent areas having the same lower end and ridges and cracks headward to a steep slides may move on permafrost table, most are shallow matrix of cataclasite (chlorite-rich, fine- crushed rock (cataclasite) in a tectonic cracking. In general have poor foundations as liquefied serpentinized ultramafic rock, rodingite dike serpentinized ultramafic rock, rodingite dike geologic conditions should be investigated to hugach Mountains and along Glenn Highway east of headwall, usually in rock. Seepage from rock and mud, broken shale, large boulders of hard rock. Poor rocks, blocks of layered gabbro, croesite rocks, blocks of layered gabbro, croesite surface drainage generally forms creek that flows Little Nelchina River. Formed of volcanic and igneous mafic, and ultramafic rocks) subsequently schist, pillow basalt, marble, chert. Includes schist, pillow basalt, marble, chert. Includes rocks on slopes oversteepened by glaciation in Chugach down slide; slide material partially to wholly liquefied Landslide deposits altered by retrograde processes. conglomerate like that in Chickaloon conglomerate like that in Chickaloon Mountians. Landslides in unconsolidated deposits are near seepages and drainage channels. Formation (Tertiary). Besides prominent Formation (Tertiary). Besides prominent serpentinite is also incompletely serpentinite is also incompletely of large, mappable slides not known, perhaps as much as 65 ft (20 m). serpentinized dunite, peridotite, and serpentinized dunite, peridotite, and Silty material is susceptible to frost action. Loose, poorly-sorted, nonstratified silty sandy gravel, Lateral and end moraines form unmodified subparallel Range from subdued to prominent subparallel ridges on Tectonic mélange of metabasalt and lesser Not present similar to ground moraine (gm) but less compacted and including much stratified sand and gravel, silt, and Not present position on side hill, and numerous local ponds till and gravelly ridges on slopes and hillsides above slopes and in lowlands to heavily kettled massive ice and settlement potential are probably relatively However, foundation conditions good to fair on ridges 3,200 ft (975 m): below that level moraines are of Talkeetna Formation, in crushed commonly mantled by lake sediments (lc/m). The most Relief as much as 80 ft (25 m). Moraines are crosse End-and lateral-moraine deposits prominent moraines are northwest of Curtis Lake, by streams, but much of the drainage is internal Suitable granular borrow locally available. oulders are angular to subrounded. west of Little Nelchina River, and between Tolsona through permeable soils. and Tazlina Hills north of Glenn Highway. Thickness Andresen and others, 1964 Andresen and others, 1964 Burns and others, 1983 Burns, 1982 Crevassed and ridged glacier surface in lateral and Generally poor for construction because of potential Ice matrix enclosing largely angular rock fragments, derived from mountainsides and transported as medial Occurs as lateral and medial moraines and as part of Glacier ice is subject to settlement upon thawing, as Detterman and others, 1976 Grantz, 1960, 1965 Grantz, 1961b, 1965 the end moraines of Nelchina, Matanuska, Tazlina and medial moraines; hummocks and collapse pits of icefor subsidence on thawing of glacial ice and because of Winkler, Silberman, and others, 1981 Grantz, 1960, 1961a, 1961b, 1965 Pessel and others, 1981 Pessel and others, 1981 eformation of foundations by glacier movement. Not and lateral moraines and deposited as ice-cored smaller glaciers in Chugach Mountains. Thickness of cored terminal or end moraines. Drainage of melt Winkler and others, 1984 Debris-rich glacial ice of medial, Winkler and others, 1984, unpublished moraine. Boulders concentrated at surface by melting Winkler and others, 1984 unpublished mapping and marginal drainage systems. A few glacier-surface local areas as a temporary road. probably more abundant than boulders entrained in ice lateral, and terminal moraines mapping streams lead to enlarged crevasses (moulins) through Silt content above 6% makes deposits frost-Talus cones are features of steep mountain slopes, Generally not well suited for construction because of Slopes may be moving by gravity creep of talus. Angular rock fragments of pebble to boulder size Most commonly occurs at the foot of and on lower Permafrost conditions not known. Similar coarse, silty which attain slopes of about 100 % at the upper limit susceptible in many locations. mountain slopes in talus cones and in avalanche chutes, deposits in other regions have permafrost that includes embedded in silty sandy matrix; nonstratified and in scree slopes on upper mountainsides, and in cirques of the cones, and as little as 10 % at the lower limit Vear-surface blocky material may, in hard rock areas poorly sorted, except where locally reworked by Chugach Mountains, be suitable for riprap, coarse Talus and rubble or toe. Scree slopes exceed 100 % in upper part, and where the deposits may border glaciers or merge fill, or dimension stone, but generally not suitable elsewhere. Excavation may activate slope movement percolates freely through the coarse materials, and than 50 ft (15 m). Rubble deposits of flat hill summits removes fines from the upper 1.5 ft (0.5 m) as it moves in steeper parts of unit. mixed with finer material, that is as much as 15 ft (5 Undesirable for construction because of potential for Susceptible to frost action. Bulb-shaped in plan view on cirque floor and at base of Permafrost probably is preserved as interstitial ice of Nonstratified, unsorted mixture of broken angular rock downslope movement and possibility for differential active and semi-active rock glaciers. Ice conten fragments in silty sandy matrix. Active rock glaciers, talus cones in the southern Talkeetna and northern talus cones; outer margin is a near-vertical slope and sufficient to cause differential settlement upon settlement upon thawing of interstitial ice. and possibly some farther downvalley that are no Chugach Mountains. Thickness not known, but perhaps Alaska Geological Society, 1970, Stratigraphic correlation sections, Copper River Basin, glaciers, a series of 6 - 15 ft. (2 - 5 m) high ridges Rock-glacier deposits thawing of ground. longer active, contain intergranular ice or ice that Alaska: Anchorage, Alaska, Alaska Geological Society Stratigraphic Committee concentric with the frontal scarp of the rock glacies contains fragments of rock that are not in contact year 1970, 3 sections, vertical scale 1 in.=400 ft. Active rock glaciers are normally those closest to the Alaska Glacial Map Committee of the U.S. Geological Survey, 1965, Map showing extent talus source in the cirque or on slopes, but those of glaciations in Alaska: U.S. Geological Survey Miscellaneous Geologic Movement is much less than 3 ft (1 m) per year Investigations Map I-415, 1 sheet, scale 1:2,500,000. American Association of State Highway and Transportation Officials (AASHTO), 1982, Normally drainage is internal through the rubble to a Recommended practice for the classification of soils and soil-aggregate mixtures beneath the frontal scarp of the rock glacier. for highway construction purposes, in Standard specifications for transportation materials and methods of sampling and testing, Part I, Specifications adopted by Cross sections AASHTO, 13th ed., July: Washington, D.C., American Association of State Probably perennially frozen, but no supporting Fine and silty sand containing more than 6% silt Topography, drainage, and sandy foundations seem Distributed between Old Man Lake and Lake Louise at Well-drained sand deposits are on flat-topped ridges Fine to medium-coarse sand, apparently a shallow-Highway and Transportation Officials Designation M145-82, p. 211-217. atisfactory for construction; lack of coarser granular subsurface data are available. is frost-susceptible; medium to coarse sand water facies, perhaps deltaic, of the glaciolacustrine levation 2,450-2,500 ft (747-762 m), where sand forms surrounded by lowland marsh and muskeg that is The cross sections on this sheet show the subsurface unconsolidated deposits and Andreasen, G. E., Grantz, Arthur, Zeitz, Isidore, and Barnes, D. F., 1964. Geologic materials and lack of data on permafrost and subjacent underlain by fine-grained lacustrine deposits (mapped deposits (Unit lc); mapped where sand can be flat-topped ridges, perhaps these are locally ice-block Lacustrine sand bedrock. A bedrock cross section (A-A') has been based on seven exploratory oil wells interpretation of magnetic and gravity data in the Copper River Basin, Alaska: materials are drawbacks. Local sources of timber deltas in which the sand is less than 15 ft (5 m) thick differentiated from glaciolacustrine deposits. Sand and test holes, ranging from 2,793 to 8,837 ft (851 to 2,794 m) deep. These wells have U.S. Geological Survey Professional Paper 316-H, p. 135-153, 2 pls., scale may grade downward into sandy foreset and silty on sandy foreset and silty bottomset beds. defined the local basement rocks (volcanic rocks of lower Jurassic age) over much of the bottomset beds; locally mantled with thin lacustrine section and apparently were drilled into or through the target formations of upper and Beikman, H. M., 1974, Preliminary geologic map of the southeast quadrant of Alaska: middle Jurassic age without achieving success (Alaska Geological Society, 1970). A cross U.S. Geological Survey Miscellaneous Field Studies Map MF-612, 2 sheets, scale section (B-B') shows materials exposed in river bluffs along the Nelchina River from Burns, L. E., 1982, Gravity and aeromagnetic modeling of a large gabbroic body near the Border Ranges Fault, southern Alaska: U.S. Geological Survey Open-File Report 82-460, 66 p., 3 pls. Burns, L. E., Little, T. A., Newberry, R. J., Decker, J. E., and Pessel, G. H., 1983, Preliminary geologic map of parts of the Anchorage C-2, C-3, D-2, and D-3 quadrangles, Alaska: Alaska Department of Natural Resources, Division of Seismic design for the Trans-Alaska Pipeline, about 18 mi (29 km) east of the maj beological and Geophysical Surveys, Report of Investigations 83-10, 3 sheets, scale Suitability of the surficial unconsolidated deposits for contruction materials and Experience in developing ground-water resources along the Glenn Highway for use area provided for magnitude 8.5 within the Chugach Mountains, a magnitude 7.0 in the by residents and businesses suggests that certain general principles apply, modified by foundations is evaluated in the description of map units on sheet 2. The basis for the Chapin, Theodore, 1915, Auriferous gravels of the Nelchina-Susitna region: U.S. Copper River Basin, and a magnitude 8.0 in the vicinity of the Denali fault in the Alaska evaluation is sampling and testing of soils believed reasonably representative of the map local conditions and exceptions to the rule. In general, the thin, relatively impermeable Range 70 mi (113 km) north of the map area (Page and others, 1972). Westward Geological Survey Bulletin 622-D. p. 118-130. units; however, individual beds and lenses within complexly stratified and lenticular glaciolacustrine and glacial deposits and thin glaciofluvial mantle yield no water or only Chapin, Theodore, 1918, The Nelchina-Susitna region, Alaska: U.S. Geological Survey extension of these design criteria earthquakes requires examination by earthquake deposits cannot represent the unit as a whole, as, for example, in pit-run material take mall supplies to dug or driven wells, but the long period of no recharge and low winter specialists of the faults within the map area and their recent activity, and would seem to Bends in section at each well site, as shown on map sheet rom a vertical section consisting of many individual beds and lenses of different water table makes many of these wells unproductive in winter. The uppermost bedrock require a minimum design magnitude of 7.0. The western part of the area, within the Detterman, R. L., Plafker, George, Tysdal, R. G., and Hudson, Travis, 1976, Geology and characteristics. Not all map units were tested. The conclusions drawn from the data, formation, chiefly relatively impermeable shale, siltstone, and fine, tight sandstone of upper Matanuska River valley is bordered by the Border Ranges/Eagle River fault and by surface features along part of the Talkeetna segment of the Castle Mountaintherefore, are useful only as a general guide for route selection or soil exploration, and the Matanuska Formation (included in map unit Sf) along the Glenn Highway has yielded Caribou fault system, Alaska: U.S. Geological Survey Miscellaneous Field Studies should not supplant the usual subsurface investigations required by good engineering through the northern Chugach Mountains as a thrust along which the Valdez Group has Map 738, 1 sheet, scale 1:63,360. practice. The soil tests, including Atterberg limits and mechanical analyses needed to been moved beneath the older igneous and metasedimentary rocks (MacKevett and Eckhart, R. A., 1953, Gypsiferous deposits on Sheep Mountain, Alaska: U.S. Geologica Tertiary gravel classify the material were made at only 20 locations, mostly in the fine-grained problem coming from gypsiferous deposits; this water is highly corrosive to metal pipe. Several Plafker, 1974; Winkler, Silberman, and others, 1981). The fault cuts Tertiary rocks, but Survey Bulletin 989-C, p. 39-60, 2 pls., scale 1:12,000 and 1:2,650. soils, and only a few in gravelly or sandy materials. Additional test results are available wells in glacial drift that is more than 66 ft (20 m) thick have located water in unfrozen is believed to have been largely inactive in the last 10,000 yrs; however, displacement of Emery, P. A., Jones, S. H., and Glass, R. L., 1985, Water resources of the Copper River in reports of subsurface testing and sampling for construction or reconstruction of state permeable lenses or beds. Tertiary gravel is an excellent aquifer where beneath the drift Upper Cretaceous talus and other Recent deposits has been detected along the fault by Burns and others Basin, Alaska: U.S. Geological Survey Hydrologic Investigations Atlas HA-868, 3 highways by Alaska Department of Transportation and Public Facilities and its or lacustrine deposits in the valleys, e.g., well 5 (map and section A-A') on Mendeltna 1983) 2.15 to 3.3 mi (3.7 to 5.1 km) east of Matanuska Glacier. Grantz (1965), Andrease marine siltstone, shale sheets, scale 1:2,000,000. predecessor organizations. Basically, the soils can be divided in five groups: (1) organic Creek where the base of gravel beneath the drift was 583 ft (178 m) below the surface. Ferrians, O. J., Jr., 1966, Effects of the earthquake of March 27, 1964, in the Copper and others (1964), Detterman and others (1976), and Silberman and Grantz (1984) in silt, peat, and muck; (2) sand; (3) sand and gravel; (4) lacustrine and fluvial silt; and (5 robably Tertiary(?) This aquifer may extend southward in Mendeltna Creek valley to the south side of Fish River Basin area, Alaska: U.S. Geological Survey Professional Paper 543-E, p. E1mapping the Castle Mountain fault and its major branch, the Caribou fault, believe that Lake where a flowing artesian well is located on the south shore (Mrs. C. R. Houston, the system is not seismically active and that movements, if any, are due to lower crus 583 (178m) Highway and Transportation Officials (AASHTO, 1982), the classification of soils and oral commun., 1984). The aquifer may have some still-unknown relation to Mendeltna sand and gravel (sandstone displacements, rather than to surface faulting. These faults are believed to splay into Ferrians, O. J., Jr., Nichols, D. R., and Williams, J. R., 1983, Copper River Basin, ir il-aggregate mixtures for highway construction purposes. Data were collected by Joe smaller faults within the Copper River Basin. Definite evidence of ground slippage in Péwé, T. L., and Reger, R. D., eds., Guidebook to permafrost and Quaternary 1000 -Kubota of the U.S. Department of Agriculture during his 1952 field studies and related Upper Cretaceous Holocene time has been noted in the Matanuska River valley west of the map area, and a geology along the Richardson and Glenn Highways between Fairbanks and The Copper River Basin saline aquifer lies generally below 2,000 ft (610 m) above laboratory work (unpublished), and from samples collected by Kubota and the writer tha possible active fault segment is located on lower Sanona Creek. No specific seismic Anchorage, Alaska: Fourth International Conference on Permafrost, Fairbanks, were later analyzed by Bureau of Public Roads, U.S. Department of Commerce, and by sea level, and, for the most part, east of the map area, except for a few gas seeps and marine shale, siltstone Cretaceous design criteria have been established as yet for the map area. Alaska, July 18-22, 1983, Guidebook 1, Fairbanks, Alaska: Alaska Department of marine shale, siltston the Alaska District, Corps of Engineers, U.S. Army, Anchorage. possible saline seepages near Tolsona Lake (well 11). Elsewhere most of the well water Natural Resources, Division of Geological and Geophysical Surveys, p. 137-175. and that from Mendeltna Springs is fresh and potable. Saline springs lie immediately east Upper Cretaceous L shale and siltstone Ferrians, O. J., Jr., and Schmoll, H. R., 1957, Extensive proglacial lake of Wisconsin age of Tolsona Creek along both Glenn Highway and Tazlina River (Nichols and Yehle, 1961 Surficial silt and admixed peat and other organic material form a mantle as thick in the Copper River Basin, Alaska (abs.): Geological Society of America Bulletin, v. as 10 ft (3 m) in poorly drained areas not only on the lacustrine silt, but also in the Slope stability problems are largely a result of glacial oversteepening of slopes during the last and earlier glaciations. Slope failure, chiefly landslides and also rockfalls undrained depressions of moraines, ground moraine, ice-contact deposits, and alluvial at least one oil well (4, map, and also under pressure in a well drilled by Pan American flood plain and terrace deposits. It is generally classified in group A-5 of AASHTO 1982 Grantz, Arthur, 1956, Possible origin of the placer gold deposits of the Nelchina area, Petroleum Corp. at Glennallen east of the map area) (Alaska Geological Society, 1970; Alaska (abs.): Geological Society of America Bulletin, v. 67, no. 12, pt. 2, p. 1807. Williams, 1970, p. 55), along with methane gas, evidently derived from the coal in thes classification and has a group index for fine-grained soils that exceeds 20, indicating very 1960, Geologic map of Talkeetna Mountains (A-1) quadrangle, and the south third of poor subgrade materials, whether dried or under natural moisture conditions. sediments (Reitsema, 1979). The water and gas have migrated from bedrock upward (unit Sf, map), for other slope failures occur in gabbro, metamorphic rocks, and perhaps Talkeetna Mountains (B-1) quadrangle, Alaska: U.S. Geological Survey through the unconsolidated deposits to either be discharged from springs and mu have resulted from failure of a rock wedge in an oversteepened slope, the base of which Sand, a constituent of a variety of deposits (map units al, at, b, e, ke, and s) was analyzed at three sites—a lacustrine sand exposed in a river bluff, a kame-esker or Miscellaneous Geologic Investigations Map I-314, 1 sheet, scale 1:48,000. volcanoes, or to become trapped beneath an impermeable bed in the unconsolidated was cut away by the glaciers. The largest area of landslides is on the south slope of Slide 1961a, Geologic map and cross sections of the Anchorage (D-2) and northeasternmost deposits, such as lacustrine silt. The potentiometric surface of the saline aquifer Mountain, where many landslides have occurred since deglaciation; the failures are in eltaic sand, and sand from beneath ground moraine on the summit of the 4,000-ft part of the Anchorage (D-3) quadrangle, Alaska: U.S. Geological Survey generally slopes eastward and southward toward the incised Copper and Tazlina Rivers, flat-lying Matanuska Formation capped by about 50 ft (15 m) of Tertiary gravel and (1,219-m) hill northwest of Eureka Lodge. The AASHTO classification of these sand Miscellaneous Geologic Investigations Map I-342, 1 sheet, scale 1:48,000. respectively, and its elevation away from these rivers may be above land surface, so that sand. The most recent slide reportedly took place not long before the 1946 inspection by 1961b, Geologic map of the north two-thirds of Anchorage (D-1) quadrangle, Alaska: deposits are either group A-2-4(o), A-2, or, where silty, A-4(2). saline water could rise in a pipe above ground level; the problems of saline water appear R. F. Black (unpublished U.S. Geological Survey field notes, 1946). Smaller slides in shale U.S. Geological Survey Miscellaneous Geologic Investigations Map I-343, 1 sheet, are common along East Fork Matanuska River. Slides and earth flows are common in Sand and gravel mixtures are largely within the A-la category of the AASHTO map area, extending eastward toward Glennallen and Gulkana. Further information may Lower Jurassic volcanics 6470 (1972m) lacustrine and colluvial silt and clay and in silty till along streams and on hillsides. Rock 1965, Geologic map and cross sections of the Nelchina area, south-central Alaska: lassification. Sand and rounded gravel occurs chiefly in kames and eskers (map unit ke), be obtained from the literature cited and from well inventories by Waller and Selkregg falls and rock avalanches in narrow chutes in steep walled valleys are local hazards. tuff, rhyolite and volcanic breccia fluvial deposits (al, at), and beach deposits (b). Other types of gravel are either more U.S. Geological Survey Open-File Report 255, 4 sheets, scale 1:63,360. (1962) and a more recent one made by R. L. Glass and others in support of current Creep on steep slopes in talus and in rock glaciers makes them poor foundations. Grantz, Arthur, White, D. E., Whitehead, H. C., and Tagg, A. R., 1962, Saline Springs, angular, more silty, or both, and tend toward the A-4 group of the AASHTO system; hydrologic studies by Water Resources Division, U.S. Geological Survey (Emery and Copper River Lowland, Alaska: American Association of Petroleum Geologists these units include colluvium (map unit c), rock glacier deposits (rg), talus (t), and landslide deposits (ls). These units were not sampled and have slope stability problems Bulletin, v. 46, no. 11, p. 1990-2002. Hawkins, D. B., 1973, Sedimentary zeolite deposits of the upper Matanuska Valley, that make them unsuited for many purposes. Sand and gravel, with both angular and Other wells among those numbered 8-25 in Waller and Selkregg (1962) are largely Perhaps the most widespread of the geologic hazards is that of permafrost, or rounded stones and increasing amounts of silt form the gravelly till or sandy till that is TD7913 (2412m Alaska: Alaska Department of Natural Resources, Division of Geological and shallow driven points or dug wells in the thin drift that covers the relatively impermeable perennially frozen ground. In the map area, it is discontinuously distributed, but is common in the morainal deposits (unit m), but rarer in the ground moraine (gm) and well No., map sheet 1 Geophysical Surveys, Special Report 6. upper Cretaceous shale and siltstone or the much more permeable Tertiary sandstone and Vertical scale present in most areas except beneath the larger lakes or streams, or in some cases glaciolacustrine diamicton included in unit lc; some of these are in AASHTO Group A-4, 1976a, Mordenite deposits and zeolite zonation in the Horn Mountain area, southconglomerate. Well 19 in Waller and Selkregg is a U.S. Army well 927 ft (281 m) deep at beneath coarse gravelly material through which water percolates readily. Depth of central Alaska: Alaska Department of Natural Resources, Division of Geological are frost susceptible, and may contain segregated ice where perennially frozen. about mile 3 (4.8 km) on the Lake Louise Road; it has a log similar to that in nearb permafrost below the land surface known from only a few wells (table) is about 80 to 100 CROSS SECTION AAI ACROSS SOUTHWESTERN PART OF THE COPPER RIVER BASIN, ALASKA and Geophysical Surveys, Special Report 9, 9 p., 2 pls., scale 1:21,120. Union Oil Tazlina Unit No. 1 (well 6, cross section AA'); the base of permafrost was 100 ft (25 to 30 m), and one well in which permafrost is 125 ft (38 m) deep; these depths are 1976b, Commercial grade mordenite deposits of the Horn Mountains, south-central Lacustrine and fluvial silt and clay and stone-poor diamicton (unit le) have be ft (30 m) deep in the Army well. Other dry holes at mile 130, 126, 135 Glenn Highway compared to maximum depths of 150 to 250 ft (46 to 76 m) in river bank exposures and Alaska: Alaska Department of Natural Resources, Division of Geological and classed as AASHTO Group A-4 where the deposit is of sand and silt mixtures, and A-6 or between Sheep Mountain and Little Nelchina River apparently bottomed in tight shale or 100 to 200 ft (30 to 61 m) in wells (Nichols, 1956, p. 8) near Glennallen, east of the map Geophysical Surveys, Special Report 11, 11 p., 1 pl., scale 1:15,840. siltstone (R. L. Glass, U.S. Geological Survey, written commun., 1984). area. Permafrost (near Glennallen) has a temperature of about 30°F (-1°C) at the leve MacKevett, E. M., Jr., and Plafker, George, 1974, The Border Ranges fault in south of zero annual amplitude (Nichols, 1966, p. 173), and, at that temperature, it is very grained soils is greater than 20 for the very plastic varved clay and silt within unit lc in central Alaska: U.S. Geological Survey Journal of Research, v. 2, no. 3, p. 323-329 easily thawed by slight changes in the ground surface temperature brought on by the banks of Tolsona Creek near the bridge, of Bottley Creek 15 mi (24 km) above its Martin, G. C., and Mertie, J. B., Jr., 1914, Mineral resources of the upper Matanuska and mouth, and of Nelchina River above the mouth of Little Nelchina River; these materials alteration of the surface conditions, as, for example, by clearing the vegetation. Much Nelchina Valleys: U.S. Geological Survey Bulletin 592-H, p. 273-299. Subsurface data of the permafrost in fine-grained deposits contains excess ice as lenses, veins, and small are a very poor subgrade, and, in addition, contain excess ice as lenses and veins which Miller, R. J., Winkler, G. R., O'Leary, R. M., and Cooley, E. F., 1982, Analyses of rock (see also cross sections on sheet 2) masses, including wedges. Thawing of this excess ice causes ground settlement. The cause differential settlement of the material upon thawing of the permafrost. Where the stream sediment, and heavy-mineral concentrate samples from the Valde amount of subsidence depends on the quantity of ice in excess of the natural voids in the Group Index is less than 20, fine-grained soils may be suitable foundations with proper quadrangle, Alaska: U.S. Geological Survey Open-File Report 82-451, 224 p., 2 pl., materials. The silty sediments locally are thick enough and contain enough excess ice to compaction and drainage: however, the ice content of permafrost is likely to be so high cause settlements of at least 3 ft (1 m); normally, however, the ice-rich material is less that settlement will take place on thawing of the ground during or following construction Nichols, D. R., 1956, Permafrost and ground-water conditions in the Glennallen area than 20 ft (6 m) thick, and settlement is several inches but may in some areas exceed a 1-6 All information on cross section A-A', No data on permafrost. Alaska: U.S. Geological Survey Open-File Report, 14 p., 2 pls. foot. The character of permafrost in each map unit is given in the description of 1966, Permafrost in the Recent Epoch: Permafrost International Conference, 11-15 Glacial till generally falls in AASHTO classification A-4, and has a generally low November, 1963, Lafayette, Indiana, Proceedings: Washington, D.C., National Group Index indicating that it may, with good drainage and proper compaction be a Academy of Sciences—National Research Council Publication 1287, p. 172-175. 7-9 30.5 Chiefly glacial drift and silty Frozen to about 20 m. Avalanches on talus slopes and floods on fans suitable subgrade material. The till of map unit gm and some of that of unit m falls in sandy and gravelly material of Nichols, D. R., and Yehle, L. A., 1961, Mud volcanoes in the Copper River Basin, Alaska this category. The till-like glaciolacustrine diamicton, landslide deposits, talus, and in Raasch, G. O., ed., Geology of the Arctic: Toronto, University of Toronto Press, In addition to rock avalanches at any time of year, many avalanche chutes above other units may be more silty, or even more gravelly, to warrant a higher or lower m possibly shale of upper Creta v. 2, p. 1063-1087. talus cones are the site of springtime avalanches of snow and rock debris which sweep all Nichols, D. R., and Yehle, L. A., 1969, Engineering geologic map of the southeastern Copper River Basin, Alaska: U.S. Geological Survey Miscellaneous Geologic ceous age. Tertiary rocks before them and commonly block passage at the foot of the hill in the accumulation exposed from drill sites 150 m area. Avalanches can be identified sometimes by the scarred, matted, and broken down Very few engineering data have been collected on bedrock. The most common up hill to summit north of high-Investigations Map I-524, 1 sheet, scale 1:125,000. appearance of the vegetation. They are particularly common in the glaciated Chugael rock units along the Glenn Highway transportation corridor are shale and sandstone (units Page, R. A. Boore, D. M., Joyner, W. B., and Coulter, H. W., 1972, Ground motion values Mountains, and less common in the more gently sloping terrain of the Talkeetna f, Sm), volcanic flows and pyroclastic rocks (map unit Vu), and sandstone and or use in the seismic design of the Trans-Alaska Pipeline System: U.S. Geological merate (unit Sc) which contains deleterious amounts of chert and coal. The shale 0-37 m lacustrine silt, sand, Coal beds reported as thick is baked and indurated west of Eureka Lodge and has been used extensively for road fill. Pessel, G. H., Henning, M. W., and Burns, L. E., 1981, Preliminary geologic map of parts gravel (outwash or ice contact) as 1.5 m. No water at total. Alluvial fans in the Chugach Mountains are formed by small tributary streams Little Nelchina To the east the shale is soft and fails in large landslides under favorable conditions on of the Anchorage C-1, C-2, D-1, and D-2 quadrangles, Alaska: Alaska Department and some basal till; 37-51 m depth. Frozen 0-5 m. which are subject to torrential floods and to frequent channel shifting following heavy slopes that have been oversteepened by glacial erosion, as at Slide Mountain. Nearby, at poorly consolidated sandstone of Natural Resources, Division of Geological and Geophysical Surveys, Open-File the Little Nelchina River crossing some difficulty was encountered in reaching refusal of rain or snowmelting. Those in the less rugged Talkeetna Mountains seem to have more el, sand or sandstone, coal; Report AOF-121, 1 sheet, scale 1:63,360. stable stream courses, a lower gradient, and perhaps a greater drainage basin storage Post, Austin, and Mayo, L. R., 1971, Glacier-dammed lakes and outburst floods in \_2200 capacity in the vegetated slopes than those of the Chugach Mountains. Nevertheless, has caused unending maintenance problems. Tests of a bulk sample of this shale from the Profile along thalweg of Nelchir Alaska: U.S. Geological Survey Hydrologic Investigations Atlas HA-455, 2 sheets, boulders in river high rainfall during summer storms can cause devastating floods. eastern end of the old (1952) bridge by the laboratory at Alaska District U.S. Army Corps 0-21 m frozen gravelly material; Gas at base of frozen ground \_ 650m and accompanying text., 10 p. of Engineers (W. M. Knoppe, written commun., December 1952) indicated a density of 112.6 lb/ft<sup>3</sup>, specific gravity of 2.6, moisture content of 11%, and saturated CBR of 10% Reitsema, R. H., 1979, Gases of mud volcanoes in the Copper River Basin, Alaska: Geochimica et Cosmochimica Acta, v. 43, no. 2, p. 183-187. at 1/10 in, and 6% at 2/10 in, and swell of 2.4%. After drying the density was 116.2 ?-79 m shale/siltstone of upper Reported frozen to 24 m **EXPLANATION** Silberman, M. L., and Grantz, Arthur, 1984, Paleogene volcanic rocks of the Matanuska  $\mathrm{D/ft^3}$ , moisture content 3.1%, saturated CBR 3% at 1/10 in, 4% at 2/10 in, and swell Cretaceous age; thin cover of The glaciers of the Chugach Mountains within the map area are not known to be of 7.2%. Los Angeles Abrasion Test of fresh material showed grading "A", Wear 38% at 500 Valley area and the displacement history of the Castle Mountain fault, in Coonrad the surging type. Nelchina and Tazlina Glaciers are each bordered by two ice-dammed W. L., and Elliott, R. L., eds., The United States Geological Survey in Alaska: revolutions. Dried lumps were pulverized; the material had 60% passing the 0.075 mm lakes which drain periodically through the ice to cause outburst floods. These sudden size, liquid limit of 39, plasticity index of 15, and was classified as CL under the Corps of Accomplishments during 1981: U.S. Geological Survey Circular 868, p. 82-86. 0-25 m frozen gravel and muck; Frozen to 25 m outbursts of water carried small pieces of ice from Tazlina Glacier to the lake and raised - 600m Waller, R. M., and Selkregg, L. F., 1962, Data on wells and springs along the Glenn ingineers system. The pulverized shale is in Group A-6 (AASHTO, 1982) and has a Group the level of the 60 mi<sup>2</sup> (155 km<sup>2</sup>) lake 5 ft (1.5 m) overnight (C. R. Houston, written Highway (State 1), Alaska: U.S. Geological Survey in cooperation with Alaska index of 7, probably marginal as a subgrade material if properly drained and compacted Lacustrine silt and Imbricated fluvial gravel Sandy topset and commun., 1984). These floods, as reflected in the gaging record on Tazlina River at the 14 78.3 0.6-5.2 m silty gravel; 5.2- Frozen 5.2 m to 38.1 m and if not frozen with excess ice to cause differential settlement upon thawing. Lumps Department of Health and Welfare, Basic Data Report, Water-Hydrological Data Richardson Highway bridge, do not happen every year, may take place twice during a No. 15, 23 p., 1 pl. of shale, so common in the sand and gravel of the alluvial deposits north of the Chugac diamicton, boulders, l3.7 m frozen silt and sand; year, generally happen in late July or August, and may be triple the normal summer Williams, J. R., 1970, Ground water in the permafrost regions of Alaska: U.S. Geological 3.7-38.1 m frozen gravel; 38.1 Mountains have caused the alluvium to fail the magnesium-sulfate-soundness test for Failure of delta front bottomset beds discharge to more than  $60,000 \text{ ft}^3/\text{sec}$  (2,000 m $^3/\text{sec}$ ) (Post and Mayo, 1971). The four concrete aggregate. Similarly, the chert and coal of Tertiary rocks have been Survey Professional Paper 696, 83 p. during 1964 78.0 m clay and hardpan; 78.0 ice-dammed lakes drain in different sequence in different years, sometimes in pairs, as surficial map units same as on map sheet 1 redistributed in some unconsolidated deposits and may cause the deposits to be unsuitable 1984, Late Wisconsin glacial retreat and lake levels, western Copper River Basin, earthquake on Tazlina Glacier in 1962, or in some years not at all. Post and Mayo suggested that the Alaska (abs.): Geological Society of America, Cordilleran Section, 80th meeting peak discharge of 1962 was caused by simultaneous drainage of the two lakes bordering Anchorage, Alaska, May 30, 31, June 1, 1984, Abstracts with Programs, v. 16, no. 5 15 54.9 0-25.9 m glacial capping, muck Permafrost conditions not vertical exaggeration x 52.8 Tazlina Glacier; in other years, when the lakes bordering Nelchina Glacier drained, no Tazlina p. 340, abstract 47,109. and wash; 25.9-26.1 m wash grav- recorded. Location on claim Collapsed sand and Glacial drift, largely ground moraine increase in discharge correlable with an outburst flood was detected, so the gradual Williams, J. R., and Ferrians, O. J., Jr., 1961, Late Wisconsin and Recent history of the el; 26.1-29.6 m silt; 29.6-Geologic hazards and special problems Lake 19 below discovery is approxgravel, some silt of seperate glaciations, above and release of water must have been further damped by storage in Tazlina Lake. The Matanuska Glacier, Alaska: Arctic, v. 14, no. 2, p. 83-90. 32.3 m blue-gray gravel, quartz, imate (Chapin, 1918, p. 61). reported 5-ft increase in level of Tazlina Lake is an increase in storage that is just about below deltaic gravel, sand and silt Williams, J. R., and Johnson, K. M., compilers, 1980, Map and description of late Tertiary Earthquakes, proximity to active faults, slope stability problems, permafrost basaltic lava, no sediment, few equal to the amount of water drained from the two lakes bordering Tazlina Glacier and Quaternary deposits, Valdez quadrangle, Alaska: U.S. Geological Survey Openavalanches, glacial lake "dumping" to raise lake levels and cause drastic increases in colors of gold; 32.3-35.9 m, vegetable muck, willow twigs; 35.9-These lakes have an aggregate area of 2.7 mi<sup>2</sup> (4.5 km<sup>2</sup>) an estimated average depth over File Report 80-892-C, 2 sheets, scale 1:250,000. river discharge and stage are among the hazards and special problems. that area of 110 ft (34 m) when full. Simultaneous impact of drainage of all four lakes or Williams, J. R., and Johnson, K. M., 1981, Surficial deposits map of the Valdez 36.6 m gravel; 36.6-41.1 m vegethe level of Tazlina Lake and the resulting peak discharge of Tazlina River might, if quadrangle, Alaska, in Albert, N. R. D., and Hudson, Travis, eds., The United States table muck, gas-bearing (ignited); coincident with glacier-melt maximum discharge of the Copper River, affect structures Geological Survey in Alaska: Accomplishments during 1979: U.S. Geological 41.1-43.5 m blue-gray gravel along the Copper River downstream from the mouth of the Tazlina River. In July 1932, Survey Circular 823-B, p. B76-B78. Earthquakes are common in southern Alaska, and many have been felt in the 43.5-45.5 m yellow gravel; 45.5 the railway bridge across the Copper River at Chitina was destroyed by high water Copper River Basin. None on record was so severe as the 8.4 magnitude earthquake of Winkler, G. R., Miller, R. J., Mackevett, E. M., Jr., and Holloway, C. D., 1981, Map and 48.5 m clean wash, no sediment augmented by a breakout flood on the Tazlina (Post and Mayo, 1971). summary table describing mineral deposits in the Valdez quadrangle, southern March 27, 1964. The southern border of the area is only 35 mi (56 km) north of the 48.5-54.9 m no log epicenter of this earthquake. Seismic shaking, landsliding, ground cracking and other Alaska: U.S. Geological Survey Open-File Report 80-892-B, 1 sheet, scale effects described by Ferrians (1966) caused slight to moderate damage to facilities. The land subsided 3 ft (1 m) at the southern edge of the area, nearest the epicenter, 2 ft (0.6 Winkler, G. R., Silberman, M. L., Grantz, Arthur, Miller, R. J., and MacKevett, E. M., CROSS SECTION BB' ALONG NELCHINA RIVER, EUREKA CREEK TO TAZLINA LAKE Jr., 1981, Geologic map and summary geochronology of the Valdez quadrangle, southern Alaska: U.S. Geological Survey Open-File Report 80-892A, 2 sheets, scale m) near Sheep Mountain, 1 ft (0.3 m) along Glenn Highway, and 0 ft along the northern border of the area (Ferrians, 1966, fig. 4). Local subsidence of the free face of fan deltas in large lakes, such as Tazlina Lake, caused large waves to cast lake ice high up on the shores. The most badly damaged building was a house that slid off its foundation toward a lake near Mile 160 Glenn Highway. Intensive ground cracking and ejection of water and fine sediment was noted on most alluvial deposits within 100 mi (161 km) of

the epicenter, and cracking of lake ice was common, especially on large lakes disturbed

by waves generated by slumping of deltas.